Stopping the Drain:

Third-Party Resistance to Water Marketing in California

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Abstract: *Growth of the water market since the early 1990s has generated controversy in California's source regions over two types of transfers – those drawing on native groundwater reserves and those resulting from crop idling. Given incomplete state-level protections for third parties who may suffer adverse effects of water sales, local authorities have responded with their own measures. In particular, many rural counties have adopted ordinances restricting groundwater exports. Some communities have restricted farmers' right to fallow land for the market. Original data on water market flows and local ordinances are used to analyze the impact of county trade restrictions on water sales and water exports. County ordinances have reduced water exports by nearly20 percent and water sales by nearly 15 percent since the mid 1990s and have shifted some exports to local buyers. Several policy options are available for mitigating third-party effects in less trade-restrictive ways. For groundwater protection, a more efficient solution lies in the establishment of local groundwater management systems. Recent test cases will provide useful guidance on the practical difficulties of implementing a transfer tax to compensate communities for the impacts of fallowing.*

Key words: *water markets, third-party compensation, groundwater management*

Water Marketing and Third-Party Impacts

In California, as elsewhere in the American West, the water needs of a growing population were met over much of the past century by investments in large reservoirs and conveyance systems, often with considerable public subsidies (Reisner, 1986; Wahl, 1989). Environmental and financial cost considerations have diminished this option over the past few decades, pushing policymakers to explore a range of alternatives to meet the demands of continued rapid growth (WWPAC, 1998). Options include expansion of non-traditional sources of supply (underground storage, recycling and desalination), conservation, and reallocation through water marketing.

A role for the market arises because use-rights to water have already been appropriated, for many decades, under the "first in time, first in right" doctrine that governs access to water in the West (Sax et al., 1991). In an era when pricing has been advocated as a solution for a wide range of resource allocation issues, water transfers are

seen as a means to accommodate the changing patterns of demand while compensating water rights holders – mainly agricultural users – for foregoing their own access on a temporary, long-term, or permanent basis.

Not surprisingly, economists have been at the forefront in making the case for water markets and in promoting policies favoring their development (e.g., Hartman and Seastone, 1970; Phelps et al., 1978; Anderson, 1983; Vaux and Howitt, 1984). Nevertheless, a number of scholars have also highlighted the potential pitfalls of a market if it fails to shield "third parties" in the source regions from negative impacts of trading (Young, 1986; Howe et al., 1990; NRC, 1992; Colby, 1995). In part, the issue is one of equity: if transfers result in a significant decrease in agricultural activity, some residents in the selling region may suffer economic losses even though the transaction enhances overall efficiency of resource use. But the issue is also one of efficiency: if the legal system governing transfers does not adequately protect other water rights-holders, transacting parties have an incentive to sell more than the optimal amount of local water, with adverse physical impacts on other water users. Both economic and physical impacts could be expected to fuel local resistance to the water market in the source regions.

This paper examines the effect of third-party issues on the development of California's water market since the early 1990s, drawing on two original databases on market transactions and on local resistance in the source counties. California provides an interesting setting for at least two reasons. First, by virtue of its frontline role in market development, the state itself is a potential generator of third-party impacts. The state began promoting the water market in the late 1970s by adopting a set of facilitative policies; in the early 1990s it became an active and, at times, lead market participant,

purchasing water for drought banks and for the environment. This direct exposure to the market and the local opposition it has engendered has kept protection of third parties on the front burner of the state's policy agenda.

California is also of special interest for its legal safeguards to shield other water users from transfer-related harm. The state's "no-injury" laws for water marketing, which are intended to prevent unmitigated physical effects of the market on third parties, are more comprehensive than in many other western states, unambiguously extending to other legal water-rights holders as well as to environmental uses.[1] However, these laws technically apply only to surface water (Gould, 1988). Groundwater accounts for as much as 40 percent of total supply but falls largely outside of the purview of state regulatory authority (CDWR, 1998; Foley-Gannon, 2000). As a consequence, the debate over protecting third parties in California is intimately linked to a wider debate over the appropriate mechanisms for sustainable management of a common pool resource such as groundwater (Ostrom, 1990; Bromley, 1992; Provencher and Burt, 1993). The implications of inadequate protections for groundwater users extend not only to water marketing, but also to the optimal use of groundwater banking as a means of augmenting supply.

The paper begins with an overview of the development of the market and the rise of local resistance over the past decade. An empirical model of water supply is then used to gauge the market impacts of local resistance. This is followed by an assessment of the

[1] The protections in some other southwestern states appear less extensive, particularly with respect to the environment (Colby, 1995; Howe, 2000). California's no-injury doctrine was established through case law as early as 1862 (Gray, 1994a). The environmental protections for fish, wildlife and instream beneficial uses were codified in Cal. Water Code § 1738 in 1980.

policy options for resolving conflicts arising from the physical externalities to groundwater users and the pecuniary externalities associated with land fallowing.

California's Experience: Market Growth and the Rise of Local Resistance

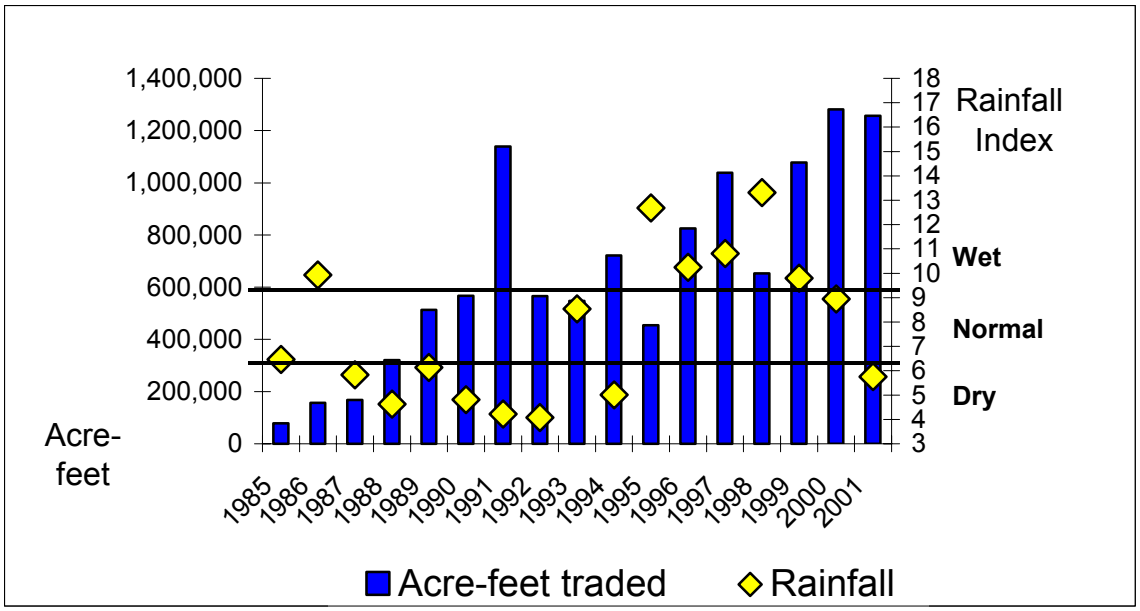
California's water market got a jumpstart with the prolonged drought of the late 1980s and early 1990s, when the state's Department of Water Resources (CDWR) and the federal Bureau of Reclamation (USBR) initiated a series of dry-year purchase programs, including water banks in several years. The impact on sales was dramatic: from 1988 to the end of the drought in 1994, state and federal purchases for resale to local agencies and for wildlife refuges accounted for over 40 percent of a market that jumped from an average of 150,000 acre-feet to over 600,000 acre-feet per year (Figure 1).

Although the second half of the 1990s saw a succession of wet years, market activity remained strong, with volumes typically exceeding the drought-year levels, especially by the end of the decade. The only dips in a generally upward trend in purchases occurred in the exceptionally wet years of 1995 and 1998, when many areas of the state experienced flooding. The market is now a firmly established – if modest – feature of the state's water allocation process, with annual trades at 1.2 million acre-feet, roughly 3 percent of combined agricultural, municipal, and industrial water use (CDWR, 1998).

Several characteristics of the market suggest that it has yet to realize its potential as a reallocation tool to meet changes in patterns of demand. As expected, agricultural water districts are the main suppliers, providing at least 90 percent of volumes sold in

most years. By contrast, the demand side of the market has behaved somewhat counter-intuitively. Economists had anticipated that a market would develop primarily as a response to population growth and the ability of urban dwellers to pay more than agricultural users for water (Phelps et al., 1978; Vaux and Howitt, 1984). Although cities were major buyers during the drought years, they have not participated in market growth since 1995.

Figure 1. Short and Long-term Water Transfers, 1985 - 2001



Source: Hanak, 2002.
Note: The unusually high volume of total purchases in 1991 reflects the excess purchases by the state in the first year of the water bank. It was only able to resell about half of the 820,000 acre-feet purchased.

Instead, the main sources of demand have been directly and indirectly linked to new environmental regulations. Direct state and federal purchases to support environmental programs have accounted for over one-third of the increase in purchases since 1995. The other growth sector, accounting for over half of market expansion, has been agriculture in the San Joaquin Valley. Farmers whose contractual water deliveries

have been cut back by environmental mitigation programs have turned to the market for replacement water.[2]

The modest role of municipal demand reflects the predominantly short-term character of the market to date; 80 percent of all trades are based on annual contracts. To support growth, many urban utilities are in search of long-term supply contracts. Such transactions are more complex to negotiate, in part because of concerns within the agricultural source regions about potential third-party impacts.

Concern over the lack of third-party protections has been a recurring theme within California's rural counties since the early 1990s water banks.[3] The banks' two principal means of water acquisition were land fallowing and "groundwater substitution" – a method whereby water rights holders sell their surface water and pump additional groundwater for their own uses. Both practices generated significant controversy (Carter et al., 1994). The fallowing issue came to a head during the 1991 water bank, for which over half the water was acquired through this method. A number of local governments and businesses registered concerns about the consequences to local economies, and one county formally requested the state to reimburse costs of social welfare programs that it attributed to unemployment created by the water sales (Gray, 1994b). Challenging both the legality of the claim and the facts on which it was based, the state declined the county's request, but it also cut the fallowing program short.

[2] Sunding et al. (1997) anticipated that access to a market could significantly reduce the costs to farmers of these programs, which forcibly reallocated supplies from agriculture to instream environmental uses.
[3] The discussion in this section is based on sources noted as well as extensive interviews with local water users and officials in California's rural counties conducted in the summer and autumn of 2002, reported in Hanak (2003, *in press*).

In the 1992 and 1994 banks, water was purchased entirely from groundwater substitution and from the handful of suppliers in a position to sell excess water in surface storage. A major controversy over groundwater substitution erupted in 1994, in a county where the state's purchases were linked to neighboring wells going dry (Thomas, 2001). What began as a local issue quickly became a regional rallying point. In effect, under the largely unregulated conditions of access to groundwater in rural California, there were fears that a water market could lead to groundwater being "mined," with potentially dire consequences for local water users. A notorious precedent was the large-scale export of groundwater from the Owens Valley in the Sierra Mountains to coastal Los Angeles beginning in the 1920s (Hundley, 2001). This surreptitious transaction, which shut down the local agricultural economy and provoked major environmental damage, still looms large in the popular sentiment of rural California.

Given the limited legal protections for groundwater users at the state level and the clear signal from the state and federal agencies that the water market was open for business, rural counties responded by putting in place their own restrictions on transfers. The legal device was the adoption of a groundwater protection ordinance, invoking the county's police power to protect public health, safety, and welfare (Hanak and Dyckman, 2003). A handful of counties had already adopted such ordinances in the late 1970s and early 1980s, in the wake of the last major drought and policy announcements from Sacramento favoring the development of a market. The floodgates opened in 1994 when Tehama County won an appellate court victory, upholding counties' rights to regulate this area given the limited state involvement. As of 2002, 22 of the state's 58 counties had adopted ordinances requiring county-level permits for direct and indirect

groundwater exports to points outside the county. Several of the ordinances explicitly regulate groundwater banking activities with outside parties; the remainder do so implicitly because the export restrictions do not distinguish between native groundwater and imported surface water banked in county aquifers.

Geographically, the group with export ordinances is concentrated in the inland rural regions: the Sacramento and San Joaquin Valleys to the center, the mountain counties to the north and east, and Imperial County to the south. With the exception of the mountain counties, which have not participated in the statewide market, these are the water market's main source regions.

No comparable legal device was available to exert county-level control over fallowing for the water market. Such transactions generally involve the export of surface water, over which the state has clear regulatory authority. Moreover, there is no legal tradition in the United States for third-party protections against pecuniary externalities. In some counties, the ordinances nevertheless reflect a broader intent to discourage any type of transfer that might harm the local economy.[4] Some water districts – the local agencies that hold most water rights on behalf of individuals – have adopted anti-fallowing policies. Not surprisingly, this appears mainly to be a practice of districts whose boards are elected by the community at large, rather than by landowners only. The recent highly publicized controversy over a proposed long-term transfer from the Imperial Irrigation District (IID) to San Diego erupted when IID – whose board is popularly elected – was pressured to fallow despite district policy against the practice. Although landowner-run districts – which constitute more than half of all agricultural

[4] This is the case in Fresno County, for instance, where officials have been discouraging long-term transfers of surface water contracts to parties outside the county even though no groundwater substitution is involved (Hanak, 2003, *in press*).

water districts – have not been more active on the market overall, they appear to have been more likely to engage in fallowing-based sales.[5]

Market Impacts of Local Restrictions

To measure the effects of local resistance on the water market, we will focus on the role of county ordinances restricting exports.[6] Because the ordinances require one or several layers of environmental review prior to permitting, one possible effect would be to delay the pace of transactions.[7] However, a review of the permitting activity in counties with export restrictions suggests that the ordinances may more useful as a deterrent than as a screening mechanism. As of late 2002, there had been fewer than 20 permit applications and only one export permit granted. High up-front costs and the likelihood of negative public opinion guiding the decision process are both factors cited as discouraging parties from filing.

If the ordinances are serving as deterrents, we might expect significant overall impacts on the volume of trades. Most ordinances address both direct groundwater exports and any surface water exports resulting in additional groundwater extraction. In counties with restrictions, the only types of transfers not subject to local approval are those involving water held in surface storage (available to few water purveyors), excess surface water (available mainly in very wet years, when demand is lower), water

[5] Of the 176 agricultural water districts within the Central Valley that hold surface water rights, 63.5 percent are landowner-run districts. Although they hold an equivalent proportion of water rights, they have actually sold less water than popular-vote agricultural districts (2.3 million acre-feet versus 4.1 million between 1990 and 2001). Precise data on the share of sales derived from fallowing is not available; Hanak (2003, *in press*) provides a review of the main transactions.

[6] Ideally, we would also have measured the extent to which water district fallowing restrictions have influenced market sales. Although the anecdotal evidence of restrictions in popular-vote districts is highly suggestive, we do not have a systematic measure of which districts have adopted such restrictions.

[7] Colby (1995) found that delays in transfer approvals significantly increased as a function of the number of protests filed; such action was only available to parties legally authorized to dispute the transfers.

conserved through efficiency gains (available only through investment outlays) or through land fallowing (available to farmers in some districts, at the expense of foregone crop income). If the ordinances reflect a public view that out-of-county sales from any source should be discouraged, even these types of transfers could be affected.

Aggregate market impacts of two types might be expected. In counties where there are willing buyers locally, the ordinances should shift supply from exports to in-county uses (generally a lower-priced market). In counties without local demand, or where the local demand is more limited than the potential supply, the ordinances should provoke an overall reduction in the volume traded. The alternative prediction – of no effects on the volumes of total transfers and transfers leaving the county – would correspond to a scenario where the ordinances are generally ineffectual.

Model and Data Sources

The analysis focuses on the 12-year period beginning in 1990, the year in which data on counties of origin and destination become more precise. Two geographical groups are of interest. The first is the set of 34 "water trading" counties – counties that appear at least once in the transactions database since 1990. This excludes the mountain counties and counties along the north and central coast. These non-trading counties are excluded for statistical reasons; the key econometric models cannot be estimated when they are included.[8] In many of these counties, there may be structural reasons for the lack of trading activity: counties along the coast and to the far north rely on local river and

[8] The inclusion of counties that never trade adds no information to the estimation of the effects of an export ordinance on trading behavior in a fixed-effects model. The presence of many counties with all zero trades also complicates the estimation of a random-effects Tobit model. For the state as a whole, the convergence properties of this model are not stable. Regression results on the full state sample are, however, consistent with the findings we report below on the effects of the export ordinances and other key variables for the 34-county sample.

groundwater sources and are not hydraulically connected to the state's main water arteries. Some local trades may occur that we have not been able to trace with our sources.

The second geographical group is the set of 18 Central Valley counties. This region has been the major source of water for the market since the early 1990s. It also has the greatest unrealized potential for groundwater-related transfer activity, through both groundwater substitution transfers and groundwater banking (Purkey, et al., 1998). The potential role of groundwater here stands in stark contrast to the situation in Imperial County, the other major market supplier. Although this county imposed groundwater export restrictions in 1996, they are unlikely to have much practical influence on the overall volume of water sales. Water users in this county have vast quantities of surface water rights form the Colorado River and, due to high salinity, few areas with usable groundwater.

The model to be estimated considers county water sales and exports as a function of a set of variables capturing water supply conditions, agricultural and residential water demand within the county, and the institutional context for markets at the local and state level. Summary statistics for these variables are presented in Table A.1.

Water supply conditions are represented by two measures of county surface water supplies and a statewide measure of rainfall conditions. Annual deliveries of project water from the three main surface water projects – the Central Valley Project, the State Water Project, and the Colorado River Project – are distinguished according to the seniority of the water rights.[9] The "senior rights" category includes those deliveries that take precedent under drought conditions. The "junior rights" category includes the lower

[9] The sources are CDWR and USBR. For details see Hanak (2003, in press), Appendix D.

priority deliveries to ordinary project contractors, typically much more variable from one year to the next. In general, we would expect counties with higher water deliveries to be more active on the water market. By the same token, individual counties should be more likely to sell in years when their deliveries are higher.

Data on other water supplies – from local surface water projects and from groundwater – are not available. We do have a general indicator of the quality of the water year, however, in the form of the state's most important rainfall measure – the Sacramento Valley 40-30-30 index.[10] Since market demands and water prices are likely to be higher in dry years, we would expect this indicator to be negatively related to sales.

Agricultural demand indicators include a measure of the average county-level price for annual crops (defined as all field and horticultural crops), the acreage under annual crops, and the share of perennial crops in total non-range acreage.[11] A priori, water sales should be inversely related to the average level of crop prices, which reflect the value of using water in agriculture. Because farmers can make adjustments in annual crop acreages fairly easily as a function of water availability, water sales should be positively related a county's crop acreage. Conversely, because a higher share of tree crops in total acreage introduces less flexibility in water use, tree crop share should be negatively related to water sales.

Residential water demands are represented by county population (CDOF, 2001). Other things equal, counties with higher populations should be less likely to sell water.

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[10] For a graphical presentation, see Figure 1. For details, see http://watsup2.water.ca.gov/hydrologic.cfm.

[11] All three series are constructed with data from the California Agricultural Statistics Service. The annual crop price is calculated using the county's prior year output, valued at the statewide average price for the current year, deflated by the western states' urban consumer price index. Annual crop acreage includes all farm acreage except perennials and rangeland. The share of tree crops is calculated as a percentage of total non-rangeland farm acreage. Acreage measures are valued at the prior year levels, to account for the fact that decisions on water sales are generally made before final planting decisions.

Institutional factors: Local restrictions are captured by the presence of an export ordinance, beginning in the year of adoption. In 1990, only two counties in the sample had ordinances; by 2000 the count was 12 for the 34-county sample and ten within the Central Valley. In 2001 one county (Glenn) removed its restrictions in favor of a more comprehensive management scheme. Over this same period, the state and federal agencies were introducing rules to make it easier for water districts to trade with each other. [12] To capture this improved environment, we include a time trend in the regressions. If the new operating rules are effectively increasing transfer activity, this variable should be positively related to sales. A time trend also captures the effect of "learning-by-doing" by water users as they gain familiarity with the market.

Tobit models taking into account the panel structure of the data are the most appropriate specification for this problem, given the bunching of the distribution of the dependent variables at zero.[13] This specification nevertheless presents two limitations compared to a linear model. The parameter estimates of the fixed-effects Tobit are potentially biased,[14] and there is no direct test of the appropriateness of the random- versus fixed-effects specification. The results were therefore tested for robustness with a linear model, for which estimates correspond closely to those presented here.[15] Hausman specification tests of the linear model fail to reject the null hypothesis of no fixed effects

[12] The most notable actions were the passage of the Central Valley Project Improvement Act in late 1992 and the State Water Project's Monterey Agreement in late 1994, both of which eased approval rules for trades among project contractors.
[13] For the 34-county sample, 31 percent of all sales and 39 percent of all exports are zero; for the Central Valley sample, the corresponding values are 11 and 18 percent, respectively
[14] This stems from the so-called "incidental parameters problem" (Arellano and Honoré, 2001).
[15] The fixed-effects Tobit models were estimated with Limdep 8.0. All other models were estimated with Stata 7.0.

at conventional levels of significance, suggesting the absence of omitted cross-sectional variables that would bias the random-effects Tobit results.[16]

Results

Table 1 presents the effects of the two institutional variables – county restrictions and the state and federal trading environment – for all trading counties and for the Central Valley. The county regulations have noticeably restricted market activity. In the trading county sample, for which random- and fixed-effects coefficients are very close, the typical county with an export restriction sold over 14,000 acre-feet less than a county without one. The estimated effect on exports is larger – at roughly 17,000 acre-feet – although the difference is not statistically significant. These results suggest that the county restrictions have not only reduced sales, but have also resulted in some shifting of water from external to within-county buyers.

There are some differences in the parameter estimates on county restrictions when the analysis is restricted to the Central Valley. With the random-effects specification, export ordinances are estimated to reduce overall sales by nearly 21,000 acre-feet, and out-of-county sales by over 26,000 acre-feet. The corresponding increase in local sales induced by ordinances is nearly 5,500 acre-feet per county per year. In the fixed-effects specification, the effects are closer to the values for the full trading county sample. Although the random-effects and fixed-effects models are not different in a statistical sense, the different results for this one variable suggest that there may be some systematic differences within this sample between counties that have adopted ordinances and those that have not. As we will discuss below, the pattern of ordinance adoption within the

[16] The Hausman test statistics for the 34-county sample generate significance levels of 0.33 for water sales and 0.15 for water exports. Corresponding values for the Central Valley sample are 0.58 and 0.52.

Valley does reflect differences in the extent to which alternative forms of groundwater management are present in the county. Most "non-adopters" have at least rudimentary forms of local oversight in place, which enabled water users to persuade county officials that an ordinance restricting exports was unnecessary.

Table 1. Market Effects of Institutional Factors, 1990-2001

	Water Sales		***Water Exports***	
Tobit model:	*Random Effects*	*Fixed Effects*	*Random Effects*	*Fixed Effects*
34 Trading Counties				
County export restrictions	-14,308**	-14,935*	-16,948**	-17,690**
	(7,246)	(7,769)	(7,722)	(8,453)
State & federal policy (time trend)	3,828***	4,210***	3,729***	4,162***
	(681)	(914)	(761)	(1,016)
18 Central Valley Counties				
County export restrictions	-20,789**	-14,893	-26,245***	-19,820**
	(8,713)	(9,449)	(9,350)	(10,003)
State & federal policy (time trend)	4,645***	3,984***	4,220***	3,292**
	(977)	(1,348)	(1,039)	(1,428)

Notes: All models also include indicators of annual crop prices, annual crop area, share of tree crop area in total, population, junior and senior water project deliveries, rainfall, and a constant.
Standard errors in parentheses. '***', '**', '*' indicate coefficient is significantly different from zero at the 99%, 95%, 90% levels of confidence in a two-way test. For full model results, see Tables A.2 and A.3.

To further explore the mechanisms by which county restrictions reduce water trades, we would ideally want to test whether the ordinances are affecting sales from groundwater-related sources alone or also those from water sources beyond their legal reach. Because detailed information on water sources is unavailable, this proposition can only be tested indirectly. To this end, a similar model was tested with binary dependent variables for sales and exports. For both geographical samples, the export restrictions

prove insignificant in explaining the likelihood of either action.[17] Thus, while the ordinances may exert a wider moral suasion effect against transfers in some counties, their main effect appears to be limited to groundwater-related sales.

The aggregate market-dampening effects of export restrictions are nevertheless substantial. Since 1996, the point at which a number of counties began to adopt ordinances, the restrictions have reduced exports by roughly 950,000 acre-feet, or 19 percent of all out-of-county sales.[18] Of this total, 150,000 acre-feet that would otherwise have been exported have been sold locally. The lion's share (800,000 acre-feet) has simply been kept off the market. In all, this represents a 14 percent reduction compared to the level of predicted sales in the absence of county restrictions. For the Central Valley counties, these effects are even larger: a 39 percent reduction in exports and a 25 percent reduction in overall sales due to restrictive ordinances.[19] The resulting shift from exports to the local market appears to have increased within-county sales by nearly 50 percent.

Meanwhile, state and federal measures to improve the trading environment plus learning, as measured by the time trend, have had a substantial positive effect on water sales. The typical county was likely to sell roughly 44,000 acre-feet per year more in 2001 than in 1990, under identical conditions of water supply and agricultural demand. During the first six years analyzed here, the positive effect of this improved environment (nearly 700,000 acre-feet) far outweighed the negative effect of county restrictions (under

[17] Binary dependent variables for sales and exports were regressed on the set of independent variables reported in Tables A.2 and A.3 with random- and conditional fixed-effects logit estimators. The only variables that are uniformly significant in determining the likelihood of sales and exports are rainfall levels and the time trend. In the random-effects specification, crop area and crop prices are also significant and of the expected sign, reflecting the substantial cross-regional variability in agricultural conditions.
[18] The cumulative market effect was calculated by multiplying the number of counties affected by the average of the fixed- and random-effects per-county coefficients reported in Table 1.
[19] Results calculated with the random-effects coefficients reported in Table 1.

250,000 acre-feet).[20] As the number of counties with restrictions has grown, this has ceased to be the case. From 1996 to 2001, county restrictions cancelled out the positive effect of state and federal policies to encourage trade, at roughly 800,000 acre-feet each.

Of the remaining variables in the supply equations, the group capturing water supply proved most significant in explaining county trading behavior (Tables A.2 and A.3). In the random-effects specification, all three variables were significant and of the expected sign. In the fixed-effects specification, the size of water deliveries to senior rights-holders had an unexpected negative impact on sales. Upon reflection, this result is easily understood. Although senior rights-holders experienced supply cuts during the early 1990s drought, the cuts were even more severe for other water users. As such, senior rights-holders were some of the only players able to sell water in these years.

Among the variables measuring agricultural and residential demand, only crop prices and crop acreage prove significant in the 34-county sample within the random-effects framework. Cross-sectional variability in the value of agricultural output is substantial – ranging from well over $300 per ton along the coast where farmers specialize in horticultural crops, to $100 per ton or less within the Central Valley, where field crops dominate. By contrast, there has been relatively little variation over time in real average county prices during the period analyzed here. A similar pattern emerges for area planted to annual crops, with little movement over time in average levels, but tremendous cross-county differences, ranging from close to a million acres in Fresno County to fewer than 50,000 acres along the coast. The cross-county variability in both prices and area is much smaller within the Central Valley, which may explain why these

[20] For method of calculation, see footnote 18.

variables are not significant determinants of valley water sales and exports in the random-effects specification.

Policy Implications

Local resistance in source regions – manifested in county groundwater export restrictions and water district bans on crop fallowing – arose because of concerns over potential negative externalities from the water market and the absence of state-level protections. The restrictions are having their intended effect of reducing market activity. They are likely to be sub-optimal measures to deal with market externalities, however, not only from a statewide perspective but also from the perspective of communities in the source regions. Export bans limit the potential revenue streams from water sales, which can be beneficial to rural economies. County groundwater ordinances also reduce the potential for communities to benefit from the development of new water supplies through underground storage. What is the scope for introducing policies less restrictive of market development, while addressing third-party concerns? The issues are distinct for the two types of harm that the market can inflict on communities – physical externalities associated with groundwater transfers and pecuniary externalities associated with land fallowing.

Groundwater Management Options to Address Physical Externalities

Economic theory provides a clear principle for the solution to physical externalities such as those generated by groundwater-related transfers in California's rural counties. For an efficient outcome, some mechanism must be put in place to induce

individuals to internalize the consequences of their own use of the resource.[21] County export restrictions can be viewed as a sensible stopgap measure to limit potential damages of an open-access groundwater system with the arrival of the water market. The market did not create the problem of externalities – indeed, some areas were already subject to significant overdraft from local use – but it significantly increased the risk that groundwater supplies would be unavailable or costly in drought years when local needs were greatest. In many places, the low level of knowledge about aquifer characteristics made it difficult to appreciate the extent of that risk.[22]

Export restrictions are nevertheless likely to be an inefficient mechanism, at once overly restrictive of transfer activity and ineffective in addressing the stability of the aquifer in areas already subject to overdraft. What are the policy options for moving beyond export restrictions to a more comprehensive management system?

The economics literature has focused on the relative merits of alternative management schemes – assignment of private property rights versus imposition of central control (Provencher and Burt, 1994); use of price versus quantity mechanisms for allocation by a central authority (McCarl et al, 1999); choice among alternative regimes for selecting the level of a pump tax (Burness and Brill, 2001). Underlying all of these options is the notion that some form of quantity- or price-based mechanism for limiting individual pumping behavior is a necessary component of efficient management.

[21] A large literature focuses on whether the externalities associated with common property groundwater regimes are sufficiently large to warrant improved management methods (Provencher, 1995). In the present context, we consider this issue moot. As Provencher and Burt (1994) note, "…when political winds blow in the direction of groundwater management, it becomes purely academic to debate whether or not the groundwater resource should be managed…the relevant question for economists is…how to manage it."

[22] For instance, within the northern part of the Central Valley, often considered an area with considerable surplus groundwater available for export, only three regional investigations of the aquifer systems had been completed in the past 80 years and none since the mid 1970s (Fulton et al., 2003).

Most of the groundwater basins in urbanized southern California and in coastal areas are managed with variants of the mechanisms described in the literature (CDWR, 2003). In adjudicated basins, individual drawing rights are quantified and monitored by a water master. In other areas, individuals have ceded their groundwater rights to a collective authority, which regulates use through a pumping fee. These systems have been established through court orders and legislative actions since the 1940s and 1950s, in response to local concerns regarding the integrity of the resource base (Ostrom, 1990; Blomquist, 1992).[23] Whatever their relative merits, there is a consensus that these systems encourage improved management (CDWR, 2003); groundwater banking and recharge activities are common, as is participation in the water market.

Rural water users have so far eschewed these more comprehensive management systems, in part due to cost considerations (a key argument against adjudication proceedings) and in part due to a desire to avoid ceding control to a central authority (and bearing the attendant pump taxes). There is, nevertheless, a movement underway toward more active groundwater management. In some places, the county itself or a special district with county-wide jurisdiction has played a convening role for county water users; in others, water districts overlying a shared basin have grouped together to develop a groundwater management plan (Hanak, 2003, *in press*). As noted earlier, most Central Valley counties that did not impose export restrictions made this choice because they already had at least rudimentary groundwater management systems in place. One county has replaced an export ordinance with a more active groundwater management scheme.

[23] Rather than the advent of a water market, population pressure and technical threats such as saltwater intrusion and land subsidence provided the impetus for introducing management schemes.

The regression results indicate that water users in these counties have been more active on the market.

These new management schemes share the objective of improving the knowledge base on the groundwater basins, through the establishment of monitoring networks, data analysis and in some cases modeling exercises. The most assertive programs have established procedures to mitigate harm to third parties from market-related activity, through compensation and potentially also cessation of pumping for export. A key question is whether a strictly voluntary management principle is adequate, or whether some form of quantity- or price-based restrictions on individual pumping is needed for the programs to be effective. Moving to more restrictive systems may be constrained by political feasibility.

Another question concerns the appropriate role for the state vis-à-vis other actors in encouraging improved groundwater management. Despite a recurring debate over whether the state should assert greater control over this resource,[24] current political realities dictate that management systems will need to be developed at the local level. There are also efficiency arguments to be made in favor of local control, because both monitoring and determination of local water demands is best done on a decentralized basis (Provencher and Burt, 1993 and 1994). But there is also a role for state-level support, given the wider public benefits of the market and of groundwater banking, which cannot proceed unless local management systems are established. The state has been active in this regard, through technical and financial assistance, made available subject to local adoption of programs with sound content (CDWR, 2003).

[24] Most recently, see the report to the State Water Resources Control Board by Joseph Sax (2002) and the associated public hearings.

In counties with export restrictions, parties with senior water rights have incentives to spearhead these more comprehensive management systems, because they stand to gain the most from market opening. Judging from initial experiences in some counties that have taken the lead on these issues, making locals comfortable with groundwater-related exports may require actions beyond ensuring adequate protection for other groundwater users. Recent transfers have been accompanied by "deal-sweeteners" in the form of bargain sales of surface water to local users in short supply. This represents a wealth transfer to others in the community rather than a correction of a physical externality.

Mitigating the Pecuniary Externalities of Land Fallowing

When local resistance to the market derives from concern over the economic impacts of land fallowing, the policy implications are less clear. There is neither an efficiency justification nor a legal tradition for mitigating the impacts of pecuniary externalities. However, some scholars have argued that there are ethical grounds for doing so, since water marketing is a policy tool of the state, and since source regions tend to be economically disadvantaged (Young, 1986; NRC, 1992; Sax, 1994; Howe, 2000). There may also be practical reasons for doing so, in places where community resistance will otherwise block a transfer from going through.

Policy options for mitigating these types of impacts fall into three basic categories: limiting the amount of land that can be fallowed locally, providing the community with a voice in the bargaining process, and establishing a scheme to compensate individuals for income lost as a result of land fallowing. All three of these measures have been put to the test in California; none is devoid of problems.

Restricting the amount of land to be fallowed within a given area will clearly reduce the market's efficiency, wherever low-valued agricultural uses of water are geographically concentrated. As Howitt (1994) showed in a study of the effects of the 1991 water bank, moderate restrictions of this nature may nevertheless be a practical way of keeping the level of losses to local businesses within politically acceptable bounds. Soon after the 1991 water bank controversy, the California legislature amended the Water Code to incorporate a loose restriction on crop idling for the market.[25] Many water districts involved in such sales impose rules on individual farmers, such as limits on percentage of land to be idled and upkeep requirements for idled fields. Such rules serve the dual purpose of maintaining the overall viability of cropland within the area and assuring the community (including other farmers) that selling water will not displace the primary business of farming.

Giving the wider community a say in the matter of land fallowing for transfers could, in principle, allow for the full (local) social benefits of the transfer to be taken into account. Colby (1995) has argued that mechanisms to incorporate third parties into the approval process can be beneficial for this reason. There is a risk, of course, that the community will be overly conservative, blocking transfers that would make good sense not only for the farmers but also for the local economy. In California, popular-vote districts automatically give the community this voice. As noted, many of these districts have blanket policies against fallowing.

In the one major fallowing transaction that may be approved by a popular-vote district – the long-term transfer from IID to San Diego – much of the debate has centered

[25] Under Cal. Water Code § 1745.05, fallowing-based sales exceeding 20 percent of a district's acreage must be subject to public review (though not to formal public approval).

on the third policy option of compensating injured parties. Because this type of sale is theoretically Pareto-improving, such a policy could in principle allow mitigation without compromising efficiency. For this reason, compensation – typically through the institution of a transfer tax – has been favored both by some economists (Howe et al., 1990; Howitt, 2001) and some legal scholars (Sax, 1994; Gray, 1996).

Theoretical merits notwithstanding, California's recent experience underscores the considerable practical obstacles to implementing wealth transfers from winners to the third-party losers.[26] Mitigation funds have been established for two long-term sales of Colorado River water (IID to San Diego and Palo Verde Irrigation District to the Metropolitan Water District of Southern California). Both CDWR and Metropolitan have also set aside such funds for purchases of water under short-term fallowing contracts in the Sacramento Valley. To date, the creation of these funds may have generated more controversy than it has resolved.

At issue are both the size of the funds and the development of appropriate programs for their use. For the short-term transfers, water districts and county governments involved in administering the funds have been reticent to establish direct compensation programs. In part, this stems from a belief that some of the transfers will generate few, if any, damages that merit mitigation, given the highly mechanized nature of the crops being fallowed and farmers' use of proceeds to reinvest in their land. There are also concerns that a direct compensation program would establish a dangerous legal precedent, generate excessive claims, and ultimately create unrealistic expectations about

[26] Using experimental methods, Howitt (2001) found that a transfer tax-based fund for paying third-party claims generates a highly efficient and stable outcome. By assuming that a perfectly informed neutral arbitrator awards payments, the research avoided the problem of incentives for third parties to over-estimate damages and file frivolous claims.

the potential community benefits from water transfers. One alternative – and the likely option in the Palo Verde case – is to use the funds for community development, without earmarking individual beneficiaries.

Taken together, these cases will provide useful guidance on what types of mitigation policies are practical for future transfers in California and elsewhere in the West. Requiring such mitigation through state law – proposed through several bills to the legislature since 1998 – would introduce inflexibility in an area where transacting parties are already testing solutions.

Table A.1. Summary Statistics for Annual County Water Sales and Water Exports, 1990-2001

	34 trading counties	18 Central Valley counties
All Sales (acre-feet)	22,734	31,461
	(40,658)	(45,842)
Incidence of Zero Sales	31 %	11 %
Out-of-County Exports (acre-feet)	19,465	25,419
	(39,075)	(44,140)
Incidence of Zero Exports	39 %	18 %
Ag & Residential Demand		
Annual Crop Prices ($/ton)	162	117
	(126)	(51)
Annual Crop Area (acres)	205,893	294,918
	(226,721)	(230,010)
Tree Crop Area in Total (%)	23.2	22.6
	(19.7)	(13.9)
Population	856,177	286,226
	(1,602,147)	(292,132)
Water Supply Conditions		
Project Deliveries (acre-feet)		
- Senior rights	243,826	178,751
	(537,918)	(210,645)
- Junior rights	179,474	247,412
	(272,842)	(346,500)
Rainfall Index	8.18	8.18
	(3.18)	(3.18)
County Export Restrictions	0.19	0.30
(1 = restriction)	(0.39)	(0.46)
Number of observations	408	216

Notes: mean values, standard deviations in parentheses

Table A.2. Determinants of Annual County Water Sales, 1990-2001: 34 Water-trading Counties (acre-feet)

	Water Sales		***Water Exports***	
Tobit model:	*Random Effects*	*Fixed Effects*	*Random Effects*	*Fixed Effects*
Ag & residential demand				
Annual crop prices ($/ton)	-75.8**	7.34	-88.9**	20.7
	(33.0)	(73.48)	(38.4)	(87.9)
Annual crop area (1,000 acres)	54.6**	99.5	37.6	-74.1
	(23.1)	(106.6)	(27.2)	(122)
Tree crop area in total (%)	-96.1	347.7	-113	-467
	(220)	(947.5)	(254)	(1,111)
Population (1,000)	-1.5	-11.6	-2.0	9.7
	(2.6)	(41.4)	(3.0)	(46.5)
Water supply conditions				
Project deliveries (1,000 acre-feet)				
- Senior rights	23.8***	-162**	28.3***	-176**
	(7.4)	(66.6)	(8.0)	(72.3)
- Junior rights	49.2***	62***	43.2***	57.3***
	(13.1)	(15)	(14.3)	(16.5)
Rainfall index	-3,529***	-3,532***	-3,235***	-3,166***
	(749)	(758)	(831)	(844)
Institutional factors				
County export restrictions	-14,308**	-14,935*	-16,948**	-17,690**
	(7,246)	(7,769)	(7,722)	(8,453)
State & federal policy (time trend)	3,828***	4,210***	3,729***	4,162***
	(681)	(914)	(761)	(1,016)
Log-likelihood	-840	-793	-787	-737

Notes: All models include a constant. Standard errors in parentheses. '***', '**', '*' indicate coefficient is significantly different from zero at the 99%, 95%, 90% levels of confidence in a two-way test.
Log-likelihoods reported for regressions with dependent variable scaled in 10,000 acre-feet, necessary for estimating the fixed-effects model.

Table A.3. Determinants of Annual County Water Sales, 1990-2001: 18 Central Valley Counties (acre-feet)

	Water Sales		***Water Exports***	
Tobit model:	*Random Effects*	*Fixed Effects*	*Random Effects*	*Fixed Effects*
Ag & residential demand				
Annual crop prices ($/ton)	-71.8	-92.1	-139	-161
	(87.7)	(129.5)	(102)	(154)
Annual crop area (1,000 acres)	11.0	219*	-30.7	42.2
	(28.8)	(129)	(32.1)	(144)
Tree crop area in total (%)	289	296	409	-329
	(364)	(1,656)	(408)	(1,792)
Population (1,000)	-18.5	124	-10.3	245
	(21.6)	(167)	(23.7)	(182)
Water supply conditions				
Project deliveries (1,000 acre-feet)				
- Senior rights	-7.2	-117.5	-10.9	-119
	(25.6)	(75.9)	(29.0)	(80.4)
- Junior rights	64.0***	72.2***	58.6***	61.2***
	(15.4)	(17.4)	(16.4)	(18.5)
Rainfall index	-5,410***	-5,524***	-4,661***	-4,534***
	(1,049)	(1,069)	(1,109)	(1,134)
Institutional factors				
County export restrictions	-20,789**	-14,893	-26,245***	-19,820**
	(8,713)	(9,449)	(9,350)	(10,003)
State & federal policy (time trend)	4,645***	3,984***	4,220***	3,292**
	(977)	(1,348)	(1,039)	(1,428)
Log-likelihood; Overall R^2	-553	-528	-534	-509

Notes: All models include a constant. Standard errors in parentheses. '***', '**', '*' indicate coefficient is significantly different from zero at the 99%, 95%, 90% levels of confidence in a two-way test.
Log-likelihoods reported for regressions with dependent variable scaled in 10,000 acre-feet, necessary for estimating the fixed-effects model.

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